

Hardware and software system of highway survey, inventory, and certification

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Abstract¹

Article primarily describes the hardware and software system designed for survey, inventory and certification of highways. The system includes the equipment and the software for mobile laboratory, which carries out video filming of the road, software module designed for data processing, computation of parameters of the road, accounting of road signs and other traffic management facilities. The program module of highway certification that provides traffic management plans development is also a part of the system.

1. Introduction

Highways are the most important component of transport system of Russia. Problem solving of achievement of sustainable growth, increase of competitiveness of domestic producers, improving of quality of life of the population, reinforcement of national security, and integration of a transport system of Russia into the international transport system largely depends on a development level of a highway network. Accurate and reliable information about road conditions is necessary for rational disposition of funds appropriated for development and maintenance of the highway network. Operations on diagnostics, certification and inventory of highways and artificial constructions are carried out for this purpose.

2. Hardware and software system for highway survey

Hardware and software system is developed for highway survey. Its services can be thought of as an information chain, as shown in figure 1. The information chain

includes data acquisition, data processing, information distribution, and information utilization [1].

Hardware and software system provides carrying out two main stages of operations. The first stage is field operations. Highway data acquisition are carried out using mobile laboratory, providing digital continuous video filming of the road at a speed between 40 and 80 km/h, and a binding of objects via GPS [2].

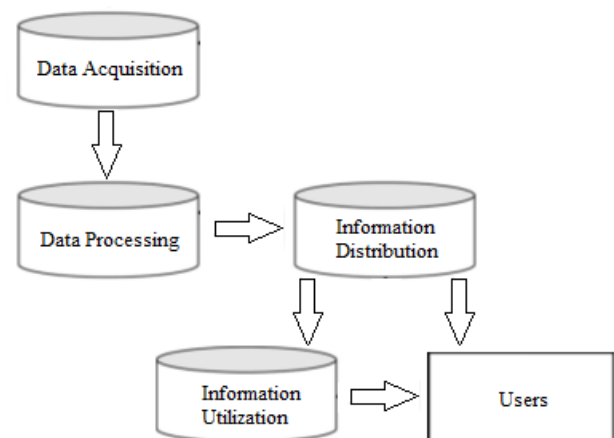


Fig. 1. Information chain

The second stage is the office operations performed by experts in the area of the traffic management involving system of data processing: program module of the accounting of geometric parameters of the carriageway.

3. Data acquisition

The equipment of mobile laboratory includes six IP cameras, each of which creates a video stream of Full HD definition with a frequency of 25 frames per second, has an IP67 level of protection from dust and water penetration, the GPS receiver with high accuracy of positioning, and a laptop.

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GPS gives to system opportunity of the round-the-clock obtaining exact coordinates and time. Data are transferred to a laptop from the GPS receiver with a frequency of 10 Hz. According to the data obtained using GPS with high accuracy the route passed by mobile laboratory is reproduced.

GPS data provided in the NMEA 0183 format (National Marine Electronics Association). Time in the UTC format, coordinates in the WGS-84 format and speed in nodes are defined by recognition of the line GPRMC representing the recommended minimum of navigation data, and altitude in metres defined by recognition of the line GPGGA that includes data on the last position fix.

Software developed for mobile laboratory provides:

- data reading in the NMEA format from the GPS receiver connected to USB port of a notebook through the virtual COM port;
- choice of web mapping service (Google maps, Bing maps, ArcGIS, Open Street Map, Yandex maps);

- display of the current location and motion path of mobile laboratory on an electronic map;
- recording data of GPS in the file on a hard drive of a laptop;
- using as a source of data of the Internet or cache for operation in a standalone mode;
- video capture from IP cameras and an output of the image to the notebook screen;
- coding and record of video on a hard drive.

The screen form, that shows the motion path of the laboratory, is provided in figure 2.

Capture, coding and recording of a video is carried out using Emgu Cv. Emgu CV is a cross platform .Net wrapper to the OpenCV image processing library, allowing OpenCV functions to be called from .NET compatible languages such as C#.

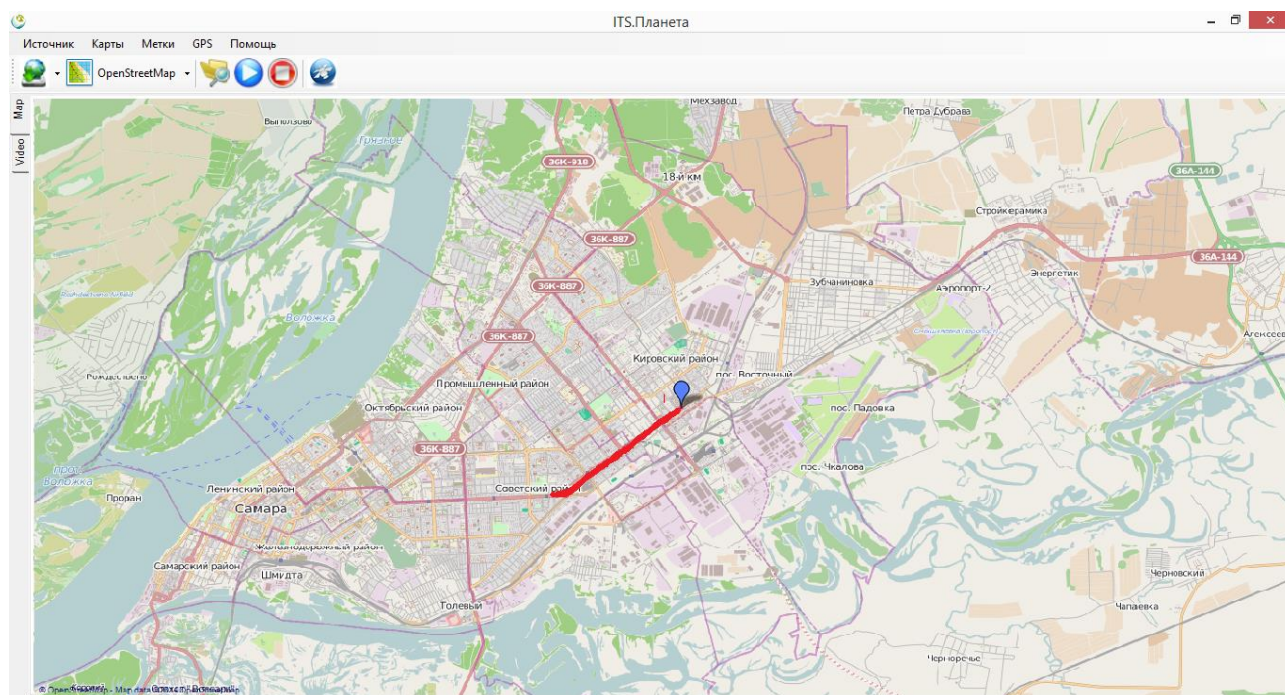


Fig. 2. Motion path of the mobile laboratory

The software provides a multithreading. For operation from each of IP cameras, the program module selects a separate flow of execution. The image from a certain camera is transferred to the laptop screen in a reduced size and filing in Full HD definition at any specific time (figure 3).

The program module realizes coding of video using the X264 codec. This is a free software library for encoding video streams into the H.264 format, which provides both high quality of video and high compression ratio.

4. Data processing

4.1 Accounting of geometric parameters of the carriageway

Program module developed for accounting of geometric parameters of the carriageway provides:

- calculation of road radiuses of curves and imaging the radiuses of curves chart, which figure 4 shows;
- measuring length, width, height of the objects;
- computation of falling gradients and displaying the road inclination diagram as shown in figure 5;
- displaying the altitude graph.

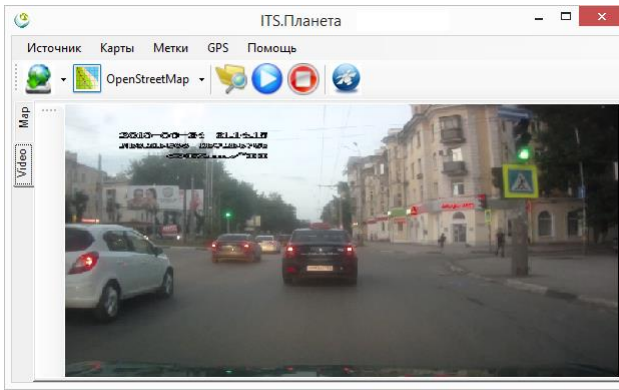


Fig. 3. Video capturing from a camera

4.2 Accounting of traffic management facilities

This software module also allows manipulating ITSGIS geographic information system database [3]. The database allows adding, deleting, and editing information about the following types of traffic management facilities:

- road signs;
- road marking;
- channelizing devices (road cones);
- pedestrian paths (pavements);
- road fences.

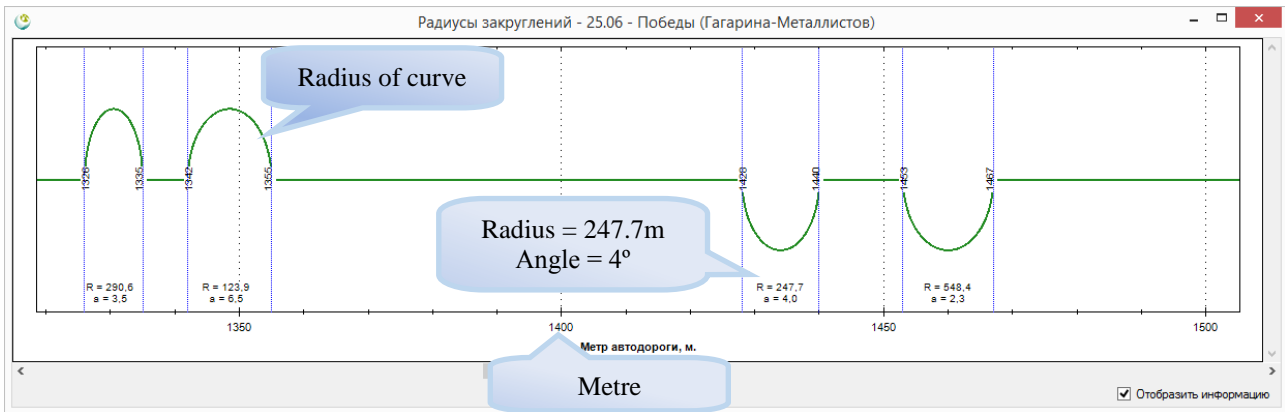


Fig. 4. Radiuses of curves chart

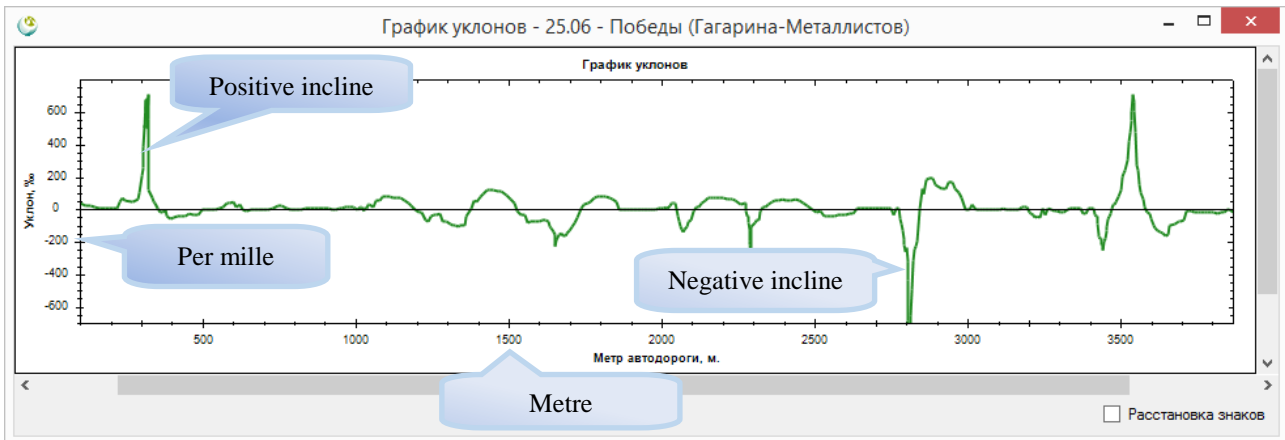


Fig. 5. Road inclination diagram

Each of the objects in a database stores information on the location in World Geodetic System (WGS-84) and the linear address relatively the beginning of the road in a (km+m) format. The screen form, which developed for adding and editing road signs, is shown in figure 6.

The program module also allows creating summary lists of road signs location, volumes of a horizontal road marking, barriers and road cones placement in the MS Word format.

4.3 Traffic management plans development

The program module of highway certification is also a part of the hardware and software system [4]. It allows

developing traffic management plans in Drawing Exchange Format (DXF), developed by Autodesk.

A traffic management plan has to include: circuits of the highway, diagram of longitudinal biases, the diagram of curves in the plan, lines of a road marking, road signs, road barriers, foot barriers, directing devices, road traffic lights, crosswalks, lighting, bus stops, foot tracks, railway crossings, artificial constructions.

Добавление дорожного знака

Номер знака по ГОСТ Р 53290-2004: 2.4

Наименование знака: Уступите дорогу

Подтип знака: [dropdown]

Типоразмер знака: 2

Площадь знаков: 0,000

Количество: 1

Адрес: 0 км 14 м

Состояние:

 Установлен

 Требуется

 Демонтировать

Месторасположение:

 Справа

 Слева

 Сверху

Таблички: [add] [edit] [delete]

№	Наименование	Состояние	Подтип
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Сохранить Отмена

Fig. 6. The screen form for adding road signs

Any object in the traffic management plan has a symbol, as figure 7 shows.

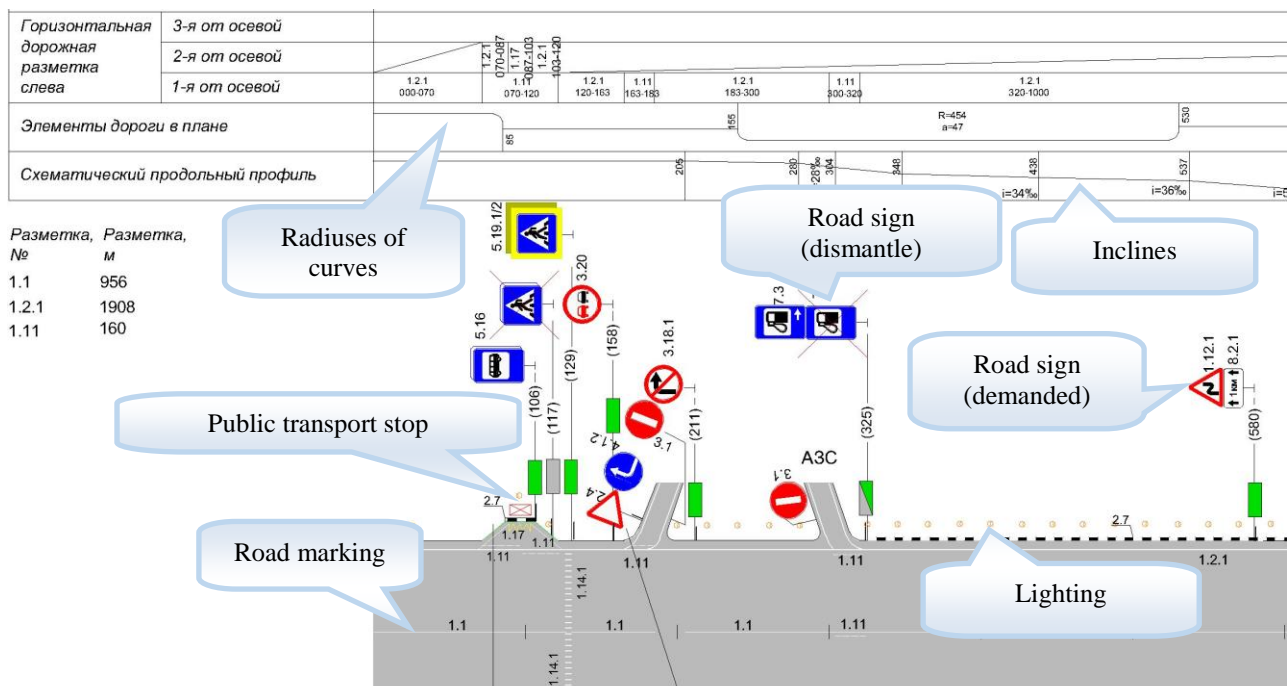


Fig. 7. The traffic management plan

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5. Conclusion

To sum up, hardware and software system was developed for highway survey, inventory, and certification. This system provides:

- Recording of video from IP cameras.
- Recording of GPS data.
- Database maintenance of traffic signs, road marking, road cones, pavements, road fences.
- Calculation of road radiuses of curves.
- Computation of falling gradients.
- Traffic management plans development.

References